Final Hazard Profile – Pipelines

Pipelines

Pipeline

Frequency	50+ yrs	10-50 yrs	1-10 yrs	Annually
People	<1,000	1,000-10,000	10,000-50,000	50,000+
Economy	1% GDP	1-2% GDP	2-3% GDP	3%+ GDP
Environment	<10%	10-15%	15%-20%	20%+
Property	<$100M	$100M-$500M	$500M-$1B	$1B+
Hazard scale	< Low to High >			

Risk Level

- Frequency –A significant pipeline incident occurs in Washington approximately every 1 to 10 years.
- People – Although people have been injured and killed by a pipeline incident, past incidents have not reached the minimum threshold for this category.
- Economy- A pipeline incident can affect the major transportation routes throughout the State and could cause major disruption to movement of goods by truck, rail, and air; resulting in a major hit to the State's economy.
- Environment – Although the environment and the species that inhabit these areas can be affected by a pipeline incident due to a spill of hazardous materials, it is not felt that such an incident will eradicate 10% of a single species or habitat.
- Property – Based on past property damage of other states as a result of a pipeline incident, an incident occurring in a heavily populated area of the State could generate property damage in the range of $100-500 million dollars.

Hazard Area Map

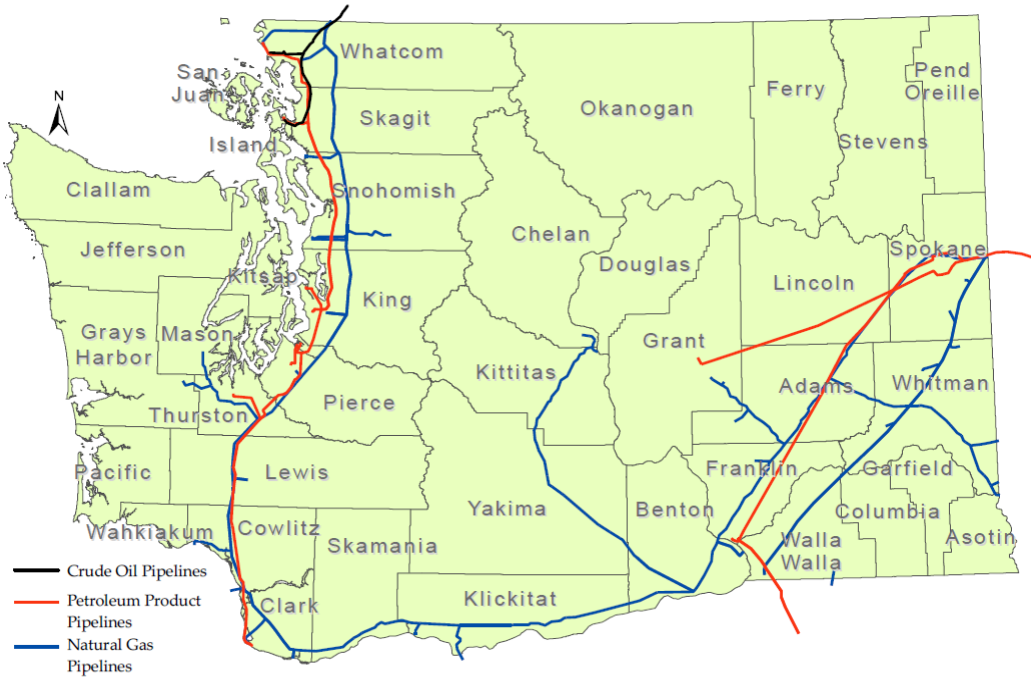

Figure 1: Washington State Pipeline Distribution Network. The location of pipelines responsible for carrying natural gas, petroleum products (including jet fuel, gasoline, etc.), and crude oil located with Washington State.

The Hazard[i, ii]

A pipeline is defined as a transportation artery that is capable of carrying liquid and gaseous fuels. Pipelines can be buried beneath the surface or can be placed above ground. Natural gas or hazardous liquid transmission pipelines run through 28 Washington counties and 119 cities. They lie buried at varying depths, carrying a range of volatile products and cross through a variety of land uses --from agriculture to urban centers. Most of the over 3,200 miles of transmission pipelines in Washington were constructed in farmland bypassing urban areas.

Washington State has the following types of pipelines: crude oil, petroleum products, and natural gas. These types of fuels are defined as:

- **Natural Gas** – Underground deposits of gases consisting of 50 to 90 percent methane (CH_4) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C_3H_8) and butane (C_4H_{10}).
- **Crude Oil** – The term used to define petroleum as it comes directly out of the ground. It is a varied substance, both in its use and composition. It can be a straw colored-liquid or a tar-black or semi-solid. Red, green, and brown hues of crude oil are common.
- **Petroleum Products** – Petroleum products is a generic name for hydrocarbons, including crude oil, liquid natural gas, natural gas, and their products. Petroleum products include; gasoline, kerosene, jet fuel, heavy fuel oil, diesel, petroleum jelly, and paraffin.

Crude oil and petroleum products travel in the hazardous liquid line while natural gas travels in the gas transmission and gas distribution lines.

Washington State Pipeline Mileage Overview

Pipeline System	Mileage
Hazardous liquid line mileage	839
Gas transmission line mileage	1,954
Gas Gathering line mileage	0
Gas distribution mileage (1,238,807 total services [A])	21,577
Total pipeline mileage	24,370
Source: US DOT Pipeline & Hazardous Materials Safety Administration http://primis.phmsa.dot.gov/comm/reports/safety/WA_detail1.html	

Previous Occurrences[iii], [iv], [v]

Two state agencies have jurisdiction over pipelines. The Washington State Utilities and Transportation Commission (UTC) is the responsible agency for the inspection and regulation of pipelines in Washington. The Commission's pipeline safety program began inspecting natural gas systems operating in Washington in 1955. Intrastate hazardous liquid pipelines were added to the Commission's responsibilities in 1996. In 2000, the Washington State Legislature approved the *Pipeline Safety Act* (HB2420), which directed the Commission's pipeline safety program to seek federal approval to include inspections of all interstate pipelines. In 2001, the State Legislature adopted the *Pipeline Safety Funding Bill* (SB 5182). In addition, in 2003, the Washington UTC became the lead inspector for all interstate pipeline inspections and incidents. The State Pipeline Inspection Program is supported through a combination of federal grants and pipeline fees. The Washington Department of Ecology is the head of the state incident command system in response to a spill of oil or hazardous substances. Ecology coordinates the response efforts of all state agencies and local emergency response personnel. Petroleum pipeline companies are required to provide Ecology with contingency plans that describe their response to oil spills should they occur. Drills are routinely conducted to test the plans.

U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA) defines Significant Pipeline Incident as those incidents reported by pipeline operators when any of the following specifically defined consequences occur: 1) fatality or injury requiring in-patient hospitalization; 2) $50,000 or more in total costs, measured in 1984 dollars; 3) highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more; 4) liquid releases resulting in an unintentional fire or explosion.

Washington All Pipeline Systems: 2002-2011

Year	Number	Fatalities	Injuries	Property Damage	Gross Barrels Spilled (Haz Liq)	Net Barrels Lost (Haz Liq)
2002	4	0	0	$281,541	49	13
2003	5	0	0	$607,827	3	3
2004	8	1	2	$1,430,008	45	25
2005	3	0	0	$61,526	1	0
2006	2	0	0	$226,260	0	0
2007	1	0	0	$38,002	0	0
2008	4	0	1	$800,596	85	71
2009	6	0	2	$933,615	1	0
2010	3	0	0	$310,530	0	0
2011	6	0	3	$790,201	0	0
Totals	42	1	8	$5,480,109	187	112
2012 YTD	3	0	0	$170,500	3	0

Source: US DOT Pipeline & Hazardous Materials Safety Administration
http://primis.phmsa.dot.gov/comm/reports/safety/WA_detail1.html

Only a few notable pipeline incidents occurred in Washington in the past 15 years. Most spills from liquid petroleum pipelines have been no larger than a few gallons. The three exceptions are from Olympic Pipe Line. On December 28, 2002 a spill of 1,465 gallons of trans-mix occurred at the Renton Control Center. This spill was caused by equipment failure and went into a containment vault. No oil was released into the environment. On May 23, 2004 a breach in a 3/8 inch sampler line caused a release of 1,890 gallons of gasoline, also at the Renton Control Center. The gasoline subsequently

caught fire and burned the sampling shed. Some of the gasoline was released to the environment. The largest release in Washington in recent years was from Olympic Pipeline when the pipeline ruptured, caught fire, and exploded at Whatcom Fall Park in the city of Bellingham on June 10, 1999. The ruptured line leaked 277,000 gallons of gasoline into a creek bed and resulted in three casualties.

On February 8, 1997, a natural gas pipeline caught fire and exploded near Everson. The explosion occurred in a remote area of mostly wooded and mountainous terrain, which was a former glacier slide area. The 26-inch pipeline involved in the explosion failed due to ground movement of water-saturated soil. The following day, February 9, 1997, a natural gas pipeline caught fire and exploded near Kalama. This explosion also occurred in a remote area and was the result of ground movement that caused a break at a weld within the pipeline resulting in the explosion.

Pipeline incidents often occur due to problems such as corrosion. Corrosion is the deterioration of metal that results from a reaction with the environment which changes the iron contained in pipe to iron oxide (rust). Corrosion can occur on the external and internal portions of the pipe and can result in the gradual reduction of the wall thickness and a resulting loss of pipe strength. This loss of pipe strength could then result in leakage or rupture of the pipeline due to internal pressure stresses unless the corrosion is repaired, the affected pipeline section is replaced, or the operating pressure of the pipeline is reduced. Pipeline corrosion creates weakness at points in the pipe, which in turn makes the pipe more susceptible to other risks such as third party damage, overpressure events, natural disasters, etc.

Events such as flooding and earthquakes can increase the likelihood of a pipeline incident. The Northridge Earthquake occurred on January 17, 1994 and damaged buildings, highways, and other structures in Southern California. In addition to building and highway damage, this earthquake damaged several crude oil underground pipelines in the area. One of these pipelines ruptured and spilled 177,000 gallons of crude oil into a storm drainage system, which flowed into the Santa Clara River. The crude oil flowed down the river for about 16 miles causing extensive environmental damage.

Heavy rains and catastrophic flooding of the San Jacinto River near Houston, Texas caused eight oil pipelines to rupture and burn on October 19-20, 1994 (Figure 2). The surging floodwaters of the river washed away soil over and under the pipelines involved in the incident, exposing them to intense hydraulic pressures that bent and twisted them until they eventually burst. These pipeline ruptures, spilled an estimated 2.5 million gallons of crude oil, refined petroleum products, and liquefied petroleum gas into the river and Galveston Bay. The fires resulting from this incident caused extensive damage to many structures that were thus unaffected by the flooding and injured an estimated 1,830 people.

Figure 2 San Jacinto River Flooding and Pipeline Explosion, October 19-20, 1994

Although only affecting the immediate area in which these incidents occur, these spills illustrate the vulnerability of pipelines in earthquake-prone and flood prone areas. Pipeline vulnerabilities to both

earthquakes and flooding should be considered when designing and building new pipelines due to the history of these events in Washington.

Probability of Future Events

There are thirty pipeline companies in Washington with the responsibility for the operation of 24,000 miles of pipelines. Over 22,000 miles of pipeline provide natural gas to residential neighborhoods and over 700 miles of pipelines carry gasoline, diesel, jet fuel, crude oil, and butane. Twenty-one of the thirty pipelines carry natural or hydrogen gas and ten of these carry hazardous liquids such as crude oil, gasoline, and jet fuel. There are nine interstate pipelines in Washington – five carry liquids and three carry natural gas. Interstate pipelines typically are large diameter pipelines that operate at very high pressures.

The transportation of hazardous liquids and gases is safer by pipelines then by any other means (Figure 3). However, if an incident occurs at a pipeline the results could be disastrous. With the continued expansion of the population in the State, especially the Puget Sound region, many people now live closer to pipelines then were originally planned. Many of these pipelines are within a few blocks of schools and in one case in Pierce County, actually run under a school playground. A major break in a pipeline at one of these locations could not only shut down major transportation routes for a short period of time to deal with the response but could affect a large portion of the community in which the event occurs.

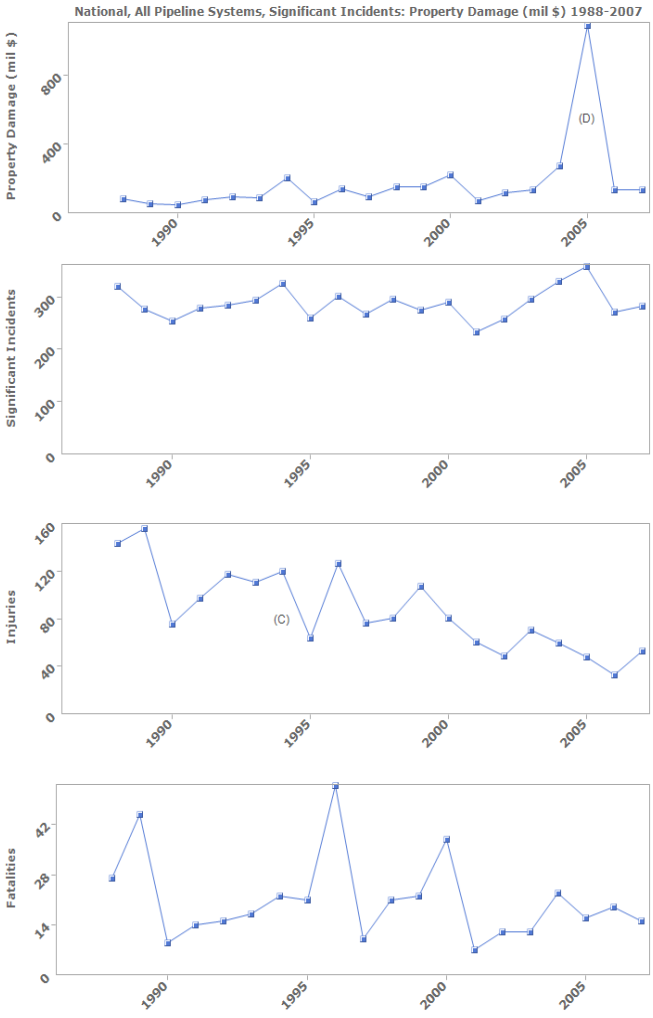

Figure 3 U.S. Pipeline Significant Incidents from 1988-2007

Pipeline incidents are the results of a rupture or break in a pipeline that causes a spill and sometimes a fire or explosion. The hazardous liquids spilled from the pipeline can damage streams, rivers, and other sensitive areas. Ignition of the hazardous liquids from the pipeline can damage sensitive areas, habitat and residential and commercial property.

Populations near pipelines are potentially vulnerable to an incident. Pipelines near rivers or streams with a history of flooding are vulnerable to an incident. Pipelines on or near earthquake faults or landslide areas are vulnerable to an incident. Pipelines near and around excavation work are vulnerable to an incident.

The best way to reduce the number of pipeline incidents occurring in Washington is to have pipeline companies fully comply with the safety measures set forth in the Washington State Pipeline Safety Act and for the Washington Utilities and Transportation Commission (UTC) to make regular inspections of pipelines. After a third party, earthquake or flood incident, the pipeline company should provide an immediate inspection, spill prevention and cleanup of damaged sections of the pipeline. The Washington Department of Ecology should oversee incident response for larger ruptures or breaks.

Possible broad mitigation strategies for reducing the vulnerability and risks associated with pipelines include: pipeline integrity management assessments; enhancing public education and awareness on the hazards of pipelines and their location near communities and populated centers; improving communication and information sharing between pipeline companies and local government agencies, particularly those involved with land-use planning and emergency management and response; and enhancing pipeline company support and cooperation with local emergency first responders.

Washington UTC Pipeline Safety Program participated in land use research to integrate mitigation land use planning efforts. The presence of a pipeline forms a relationship between pipeline operator, local government and property owner. How this relationship is managed can affect directly the safe operation of the pipeline and consequently the public health and safety of the surrounding community. In 2004 and 2005, a group of city, county, state and industry representatives conducted a series of workshops throughout the state for local government officials, talking in particular with planning, permitting and public works sections. The purpose of these workshops was to exchange ideas and explore the range of tools available to manage and make effective decisions concerning land use in proximity to transmission pipelines. This report titled *Land Use Planning In Proximity to Natural Gas and Hazardous Liquid Transmission Pipelines in Washington State, June 2006*[vi] is the product of that research.

Jurisdictions most Threatened and Vulnerable to Pipeline Hazards[vii]

Most of the over 3,200 miles of transmission pipelines in Washington were constructed in farmland bypassing urban areas. However, to accommodate population and economic growth, land areas once considered rural are being absorbed into expanding urban growth areas and developed to urban uses.

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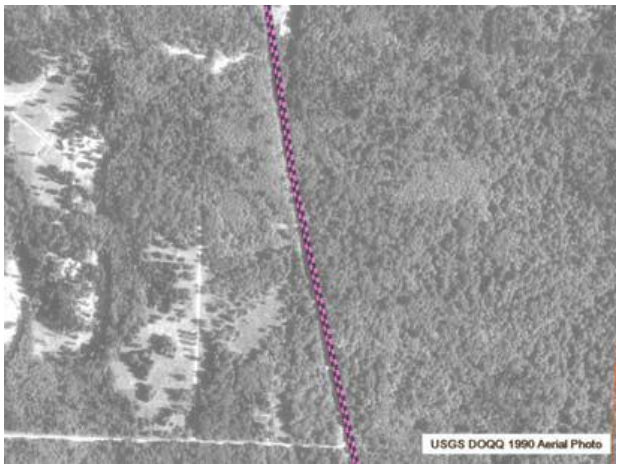

Figure 1 - 1990

Figure 2 - 2002

Nine of the state's 10 fastest growing counties in 2005 are home to almost half of the state's major pipeline mileage. This growth means more and more people are working and living near major pipelines. Increases in population and land use activity expand the risks of pipeline damage and raise the stakes in the event of a pipeline incident. The pictures above were taken of the same area in Washington State – 12 years apart

Pipeline safety and environmental regulations have generally focused on the design, operation and maintenance of pipelines and incident response. They have not directed significant attention to the manner in which land use decisions in proximity to pipelines can affect public health and safety. Building codes and development regulations for critical areas, seismic resiliency, fire prevention, etc work. Now this methodology is being applied to pipelines.

Potential Climate Change Impacts[viii,ix,x,xi]

With the advent of climate change coming into worldwide focus; it is necessary to take into account the potential effects this emerging climate crisis may have on the dangers associated with pipeline failures. The research done so far indicates the potential for unusual or more frequent heavy rainfall and flooding is greater is some areas while the potential for drought is predicted in other areas. Landslide frequency is correlated with heavy rainfall and flooding events.

According to a 2005 Governor's report prepared by the Climate Impacts Group titled *Uncertain Future: Climate Change and its Effects on Puget Sound*, from "paleoclimatological evidence, we know that over the history of the earth high levels of greenhouse gas concentrations have correlated with, and to a large extent caused, significant warming to occur, with impacts generated on a global scale." While the report also indicates that the "ultimate impact of climate change on any individual species or ecosystem cannot be predicted with precision," there is no doubt that Washington's climate has demonstrated change.

In July 2007, the Climate Impacts Group launched an unprecedented assessment of climate change impacts on Washington State. *The Washington Climate Change Impacts Assessment* (WACCIA) involved developing updated climate change scenarios for Washington State and using these scenarios to assess the impacts of climate change on the following sectors: agriculture, coasts, energy, forests, human health, hydrology and water resources, salmon, and urban stormwater infrastructure. The assessment was funded by the Washington State Legislature through House Bill 1303.

In 2009, the Washington State Legislature approved the *State Agency Climate Leadership Act* Senate Bill 5560. The Act committed state agencies to lead by example in reducing their greenhouse gas (GHG) emissions to: 15 percent below 2005 levels by 2020; 36 percent below 2005 by 2035; and 57.5 percent below 2005 levels (or 70 percent below the expected state government emissions that year, whichever amount is greater.). The Act, codified in RCW 70.235.050-070, directed agencies to annually measure their greenhouse gas emissions, estimate future emissions, track actions taken to reduce emissions, and develop a strategy to meet the reduction targets. Starting in 2012 and every two years thereafter, each state agency is required to report to Washington State Department of Ecology the actions taken to meet the emission reduction targets under the strategy for the preceding biennium.

Recognizing Washington's vulnerability to climate impacts, the Legislature and Governor Chris Gregoire directed state agencies to develop an integrated climate change response strategy to help state, tribal and local governments, public and private organizations, businesses and individuals prepare. The state

Departments of Agriculture, Commerce, Ecology, Fish and Wildlife, Health, Natural Resources and Transportation worked with a broad range of interested parties to develop recommendations that form the basis for a report by the Department of Ecology: *Preparing for a Changing Climate: Washington State's Integrated Climate Change Response Strategy*.

Over the next 50 - 100 years, the potential exists for significant climate change impacts on Washington's coastal communities, forests, fisheries, agriculture, human health, and natural disasters. These impacts could potentially include increased annual temperatures, rising sea level, increased sea surface temperatures, more intense storms, and changes in precipitation patterns. Therefore, climate change has the potential to impact the occurrence and intensity of natural disasters, potentially leading to additional loss of life and significant economic losses. Recognizing the global, regional, and local implications of climate change, Washington State has shown great leadership in addressing mitigation through the reduction of greenhouse gases.

At Risk State Facilities[xii]

Was not determined or mapped at the time of writing.

References

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